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it as seen by me than that given by W. H. Pickering (*Monthly Notices*, vol. lxii. p. 85).

When the Sun is seen through a telescope low down it is bordered at its lower edge, owing to refraction, with the red end of the spectrum, which looks on the whole red or orange-red, while at its upper edge it is bordered with the violet end, which is on the whole green, the extreme end of the spectrum being of course absorbed by the atmosphere. The edges necessarily boil much, but the last portion to set must naturally be a part of the green upper edge, and although I have not observed the green flash with the telescope it is obvious that it is this green edge that is last seen by the naked eye; the boiling of the edge will no doubt account for the appearance like Baily's beads described by one observer with instrumental means.

West Hendon House, Sunderland:
1902 *Jan.* 16.

Note on the "Green Flash" at Sunset.

By Major E. H. Hills, R.E.

The notes on this subject by Mr. W. H. Pickering (*Monthly Notices*, lxii. p. 85, 1901 November) and Mr. Backhouse above have suggested to me that it may be of some interest if I give a short account of my observations of this phenomenon and of the conclusions I have reached as to its cause. There is, I believe, no doubt that it is of spectral origin, the green being the visually predominant colour in a solar spectrum which attains the requisite degree of purity when the light source, namely the diminishing segment of the Sun's disc, becomes narrow.

If this explanation be the correct one, it will follow that, though the green may be by far the strongest colour, it will not be the last one visible, and a careful scrutiny, under suitable telescopic power, should reveal the more refrangible parts of the expiring spectrum, and thus, as the last portion of the Sun's rim finally disappears below the horizon, we should see the green fade away into blue and violet.

This I have actually observed at least twice, and I have no reason to doubt that it is visible at any time that the atmospheric conditions favour the appearance of a strong green flash.

In observing I used a Zeiss binocular, with a magnifying power of 12 diameters, and was careful to avoid eye fatigue by looking at the Sun only when a very small portion remained above the horizon. Under these circumstances the narrowing segment, which is, of course, of an orange-red colour, is first seen to turn green at its two extremities; the green colour then appears to run inwards until the whole area of the segment appears coloured.

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This is the moment when it is visible to the naked eye as the green flash, and after a duration of about a second the green fades away and is momentarily replaced by a blue or blue-violet. The latter is immeasurably more feeble than the green, and its visibility only lasts a small fraction of a second, but it is quite unmistakable, and its appearance seems to prove beyond any question the spectral character of the colours seen.

Further evidence, all tending in the same direction, is found in the fact that the green flash is better seen when the eye has not been previously tired by looking at the red disc of the Sun, whereas if it were a complementary, or fatigue, colour a certain amount of previous gazing is absolutely necessary, and also in the well-authenticated appearance of the same phenomenon at sunrise (see *Nature*, vol. lx. p. 511, 1899 August 31, where Lord Kelvin gives an account of its being seen by him at sunrise in Switzerland), when any retinal fatigue is out of the question. The conditions favourable for its appearance would seem to be :—

1. An atmosphere free from haze and dust; otherwise the light of short wave length will be dispersed and lost, and the green thus made faint or altogether obliterated.
2. A distant horizon, whether land or sea is immaterial ; but, as a dusty atmosphere is practically impossible over the sea, it is on the latter that the phenomenon is generally noticed.

   The distance of the horizon line is an important point. If the air were perfectly free from dust and haze it would be immaterial, within large limits, where the horizon is situated, but practically it is necessary to get as long a column of unilluminated air in front of the observer as possible, and therefore the more distant the horizon the more likely is the flash to make its appearance. I have, for instance, repeatedly tried to see it with a land horizon at about two miles distance, and have, under these circumstances, always failed.
3. A still atmosphere and one homogeneous as to its temperature, or in other words conditions identical with those necessary for good "seeing" in a telescope ; otherwise the irregular dispersion of the air will mask the purity of the colours.

Condition No. 2 leads us up to the fact that the best conceivable circumstances for seeing it would be when the Sun sets behind the horizon at the maximum possible distance—namely, the Moon—provided that the observer is so situated that the Sun is at a very low altitude at the time of eclipse.

Observers of eclipses have naturally always placed themselves so as to get the Sun at as high an altitude as possible, so that the appearance of the green flash at the moment of second or third contact in the case of an annular or total solar eclipse has not yet been recorded.

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